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The effects of under-skilling on need for recovery, losing employment and retirement intentions among older office workers: A prospective cohort study

Fleur G. GOMMANS,* Nicole W.H. JANSEN,* Dave STYNEN,* IJmert KANT* and Andries de GRIP**

Abstract. *Based on a sample of older workers from the Maastricht Cohort Study, the authors investigate the prevalence and dynamics of self-reported under-skilling and its effects on workers' need for recovery, their risk of losing employment and their retirement intentions over a two-year period. They find that being under-skilled is associated both with higher levels of need for recovery over time and with the risk of losing employment, but not with early retirement intentions. To achieve sustainable employment, they argue, the course of under-skilling should be monitored throughout workers' careers, enabling timely interventions to avoid its negative consequences.*

In many industrialized countries the population is "greying" (Rechel et al., 2013), resulting in a steadily ageing workforce as well as increasing difficulties in sustaining current pension systems (van Soest and Vonkova, 2014). Accordingly, many countries are pursuing policies aimed at increasing the labour force participation of older workers, by abolishing early retirement schemes and postponing the mandatory retirement age (de Grip, Fouarge and Montizaan, 2013).

A multitude of factors might affect the labour force participation of employees, however, including the extent to which their skills match the skills demanded in the job (Hidding et al., 2004).[1] The ILO (2014) has estimated

* CAPHRI School for Public Health and Primary Care, Maastricht University, emails: fleur.gommans@maastrichtuniversity.nl; nicole.jansen@maastrichtuniversity.nl (corresponding author); dave.stynen@maastrichtuniversity.nl; and ij.kant@maastrichtuniversity.nl. ** Research Centre for Education and the Labour Market (ROA), Maastricht University, email: a.degrip@maastrichtuniversity.nl.

[1] In the literature, the terms "skills" and "competencies" are often used interchangeably. In the present study, the term "skills" will be used.

that 30 to 50 per cent of all European employees experience some type of skill mismatch in their job. As the risk of being under-skilled is assumed to be especially high among older workers (Cedefop, 2010), the present study investigates the effects of under-skilling among a sample of older employees. Possible underlying causes of under-skilling might include changes in the workers themselves, such as ageing and depreciation of skills, as well as changes in the work environment, such as new job requirements (van Loo, de Grip and de Steur, 2001). Also, a reduced willingness to train or reduced access to training might result in a lack of the skills that are required to perform adequately on the job (see Ng and Feldman, 2012; Erdogan et al., 2011). Moreover, under-skilling might be the result of an interaction of multiple contextual factors involving skill supply, skill demand and personal characteristics (European Commission, 2012) – and this process might be dynamic over time.

This study aims to contribute to the literature by investigating the prevalence and possible consequences of under-skilling among older workers, with a focus on their need for recovery (NFR) at the end of the working day, the risk of losing their job and their intention to retire at an early age. Although skill mismatches are known to be negatively associated with different labour outcomes, such as job satisfaction (see Allen and van der Velden, 2001), the effect of skill mismatches on health outcomes has yet to be investigated.

In this article, we will investigate whether under-skilling is related to workers' NFR at the end of a working day (van Veldhoven and Meijman, 1994). As under-skilled employees might lack the skills necessary to perform their current job to acceptable standards, they may face a higher depletion of mental and physical resources at the end of the working day which may, in turn, result in higher levels of NFR. NFR reflects the short-term effects of a working day and employees with elevated levels of NFR are often characterized by feelings of overload, social withdrawal and reduced performance (van Veldhoven, 2008). Moreover, as under-skilled employees might not or no longer be able to adapt to changing conditions or technological changes in the job, they might be at risk of losing their job (Klimplová, 2012). In this respect, it is also possible that under-skilling is associated with the risk of job loss via the indirect pathway of NFR, as elevated NFR has been found to be associated with sickness absence (de Croon, Sluiter and Frings-Dresen, 2003), occupational mobility (De Raeve et al., 2009) and occupational disability (Otten et al., 2012). NFR has also been found to be associated with early retirement (Oude Hengel et al., 2012), suggesting that under-skilled employees might have stronger intentions to retire at an early age. However, direct associations between under-skilling and retirement intentions have not been investigated among older workers to date.

As most jobs require multiple types of skills, under-skilling might arise in regard to particular skills. Indeed, Perry, Wiederhold and Ackermann-Piek (2014) conclude that looking at only one skill domain does not provide a complete picture of skill mismatch. Moreover, it remains unknown whether associations between under-skilling and various outcomes differ across specific types

of skills. For example, being under-skilled in terms of problem-solving abilities might have an effect that differs from that of being under-skilled in terms of keeping up with new developments. In the present study, we therefore also investigate the impact of being under-skilled in regard to various types of skills.

The relationship between (various types of) under-skilling and outcomes such as NFR might be influenced, inter alia, by demographic factors (e.g. sex), workers' health (e.g. self-perceived health) and the work environment (e.g. job autonomy, high job demands), which will therefore be controlled for in our analyses. Also, as age might be a possible confounder, we stratify all results by age.

Additionally, the prevalence and nature of under-skilling might differ across industries, occupations and individuals (Kalleberg, 2008). Employees in occupations in which fast technological changes are highly prevalent might be especially prone to under-skilling, as technological changes typically require new skills. In the past two decades, occupations in the office environment have been particularly affected by such changes due to the fast development and diffusion of information and communications technologies (ICT) (CBS, 2014). Accordingly, we first investigate the prevalence of under-skilling among a population of office workers whose jobs require a high density of ICT skills, as they might be a high-risk group in this respect. We then go on to investigate the dynamics of under-skilling as well as the impact of (various types of) under-skilling on a range of outcome measures in this specific segment of the labour market. Focusing our study on office workers also results in a more homogenous population, particularly in terms of possible confounders.

The remainder of this article is structured into three main parts. The first, on methods, presents the construction of our study population, our measures and our statistical analyses. The second part reports the results of our analyses, while the third presents a discussion of our key findings and some concluding remarks.

Methods

Study population

The data we use are from the Maastricht Cohort Study, which was set up in May 1998 and included 12,140 employees at baseline. The data are collected by means of self-administered questionnaires. For the purposes of our study, the October 2012 measurement is used as the baseline (n=4,783), and the study period ends at the October 2014 wave of the survey.

To construct a homogeneous sample of older office workers, the following inclusion and exclusion criteria were applied. Only respondents between 45 and 63 years old who were employed at the 2012 study baseline were included. Those older than 63 years were excluded, as these employees were only a few years away from retirement and therefore likely to have a different outlook on retirement, which might be associated with changes in the

outcomes and consequently bias our results. For the same reason, employees who were partly retired at the study baseline date were also excluded. We excluded those who were (partly) disabled from work, on sabbatical leave, pregnancy leave or parental leave as well as those who were fully self-employed. Furthermore, employees with multiple jobs, pregnant women, and shift workers were also excluded, as were employees who were over-skilled both on the general item on skill mismatch and on each of the nine specific skill items (n = 2), as these employees would not be included in any of the longitudinal analyses. To focus on office workers only, we further included only those employees who indicated that they sat down (very) often during working days. These criteria resulted in a study population of 1,452 individuals, of whom 758 were aged 45–54 years and 694 were aged 55–63 years (this subsample was used for the analyses reported in Appendix tables A1 and A2).

To focus specifically on office workers in jobs with high ICT density, we further included only those employees who reported that their job demanded a (very) high level of "the ability to use ICT for general administrative and/or communicative purposes". This resulted in a study population of 1,111 individuals, of whom 574 were aged 45–54 years and 537 were aged 55–63 years.

An additional exclusion criterion was introduced in order to construct the study population investigated in the longitudinal analyses: all employees who were (partly) retired at the time of the October 2014 wave were excluded because the measurement of (other) outcomes for these employees may be biased due to their situation. This resulted in a study population for the longitudinal analyses of 915 individuals, of whom 498 were aged 45–54 years and 417 were aged 55–63 years.

Measures

Skills

Different items were used to assess different types of skill (mis)match. Based on each item separately, employees could be classified as perceiving under-skilling, a skill match or over-skilling. As the present study only aims to investigate the impact of perceived under-skilling by comparing under-skilled employees to those perceiving a skill match, employees who were classified as over-skilled in regard to a particular type of skill were excluded from the analyses investigating that particular skill.

One item derived from a questionnaire of the Institute for Labour Studies (2008) was used to assess whether a general skill (mis)match was perceived among employees surveyed in the October 2012 wave, namely: "How do you assess the relationship between your knowledge and skills and the work which you perform?" The three response options were: the level of my knowledge and skills "are below the job demands" (general under-skilling), "are approximately on the same level as the level required in the job" (general match) or "are above the job demands" (general over-skilling, which implies exclusion from this particular study).

Nine types of skills were measured in the October 2012 wave. They were selected from a broad range of skills assessed in the British Employer Skills Survey (IFF Research, 2013). The item "the ability to use ICT for general administrative and/or communicative purposes" was used to select a population of office workers who were involved in jobs featuring high ICT density. The eight remaining skills were considered as variables of interest, namely: "general knowledge on my own occupation", "the ability to use ICT for specific work-related purposes", "the use of communicative skills", "the ability to plan and match work with colleagues", "the ability to notice, analyse and propose solutions to problems", "the ability to cope with changes in the job", "the ability to keep up with new knowledge and developments" and "the ability to communicate in the English language". Four of these nine skills were measured again in the October 2014 wave, namely: "general knowledge on my own occupation", "the ability to plan and match work with colleagues", "the ability to cope with changes in the job" and "the ability to keep up with new knowledge and developments".

For each type of skill separately, two items were combined to measure whether employees experienced a match or perceived themselves as under- or over-skilled. The first item assessed the employees' *required skill level in the job* using a five-point-scale ranging from very low to very high. If a specific skill was not required at all in the job, respondents could indicate that this skill was not applicable. In the second item, employees assessed *their own skill level* for each skill on an equal five-point scale. When employees had the same score on both items for a given skill, this was classified as a skill match regardless of their score. If the required skill level was higher (≥ 1 point higher) than the employee's own level, this was classified as under-skilling; and if the required level was lower (≥ 1 point lower) than the employee's own level, this was classified as over-skilling, which entailed exclusion. For each skill separately, we thus determined a perceived skill match, under-skilling or over-skilling. To investigate the dynamics in skills among those who were under-skilled at baseline, three possible developments were defined for the two-year follow-up period between October 2012 and October 2014, namely: no dynamics (under-skilled in both waves), transition from under-skilled to a skill match, and transition from under-skilled to over-skilled. If an employee indicated that a specific skill was not applicable to his or her job, the skill (mis)match was defined as missing.

Need for recovery

NFR was assessed in the October 2012 and October 2014 waves. This concept was measured by means of a subscale of the Dutch Questionnaire on the Experience and Evaluation of Work (VBBA) comprising 11 dichotomous items (yes/no) and resulting in a total scoring range of 0–11 (for a description of the VBBA scale, see van Veldhoven and Broersen, 2003). To investigate the continuous NFR scores, the subscale was also recoded into a continuous scale with a range of 0–100, in which a higher score implies a higher level of NFR. Based on Broersen et al. (2004), a cut-off point of six on the 0–11 scale was

used to identify employees with an undesirably and acceptably high level of NFR (hereinafter "NFR caseness") and those – scoring below the cut-off point – with a low-to-medium level of NFR.

Losing employment

The employment status of all respondents was determined in the October 2014 wave. First, employees indicated whether or not they were currently in paid employment. Second, they could also specify that they were currently self-employed, and whether this involved full-time or part-time self-employment. Employees who reported being in paid employment or in full-time or part-time self-employment were considered as not having lost employment. All other respondents were classified as having lost employment, irrespective of the underlying reason(s).

Retirement intentions

Following Harkonmäki et al. (2006), the question used to assess early retirement intentions was: "Have you considered retiring before reaching your mandatory retirement age?". The three response options were: "no", "yes, sometimes" and "yes, often". These were further dichotomized into: "no" and "yes, sometimes", which were considered as indicating weak retirement intentions; and "yes, often", which was recoded as indicating strong retirement intentions.

Confounding factors

Potential confounders were all assessed in the October 2012 wave. Those pertaining to the personal and health domain comprised sex, educational level and self-perceived health. Current educational level was recoded into three levels: low (primary school, lower vocational education), medium (lower secondary school, intermediate vocational school, upper secondary school) and high (higher vocational school, university). One item from the SF-36 Health Survey (Aaronson et al., 1998) was used to measure self-perceived health, namely: "How would you rate your health, in general?". In line with an earlier study by Dalstra et al. (2002), the five response options – "excellent", "very good", "good", "moderate" and "bad" – were dichotomized by grouping "excellent", "very good" and "good" into "good health"; and "moderate" and "bad" into "poor health".

Potential confounders from the work environment comprised the number of working hours and various aspects of job content. A single item was used to assess the number of working hours per week, with five response options: > 40, 36–40, 26–35, 16–25 or < 16 hours per week. To construct our variable of interest, these response options were recoded into three categories: ≥ 36, 26–35 or ≤ 25 hours per week. To assess aspects of job content, four subscales from the Job Content Questionnaire (JCQ) were included: psychological job demands (five items), decision latitude (combining nine items from the subscales on decision authority and skill discretion), supervisor social support (four items) and co-worker social support (four items) (see Karasek, 1985). Each of the subscales from the JCQ had four response options, ranging from

"strongly disagree" to "strongly agree". To construct our variable of interest, the total scores on the subscales for psychological job demands and decision latitude were grouped into tertiles, resulting in low, medium or high levels of psychological job demands and decision latitude. The total scores on the subscales for supervisor social support and co-worker social support were dichotomized at the median, resulting in low or high social support.

Methodology

Although we initially aimed to stratify all results by age group, age stratification was not feasible in the analysis investigating the impact of under-skilling on the risk of NFR caseness because of the small number of incident cases of elevated NFR. In all other analyses, our results are stratified for the two age groups, i.e. 45–54 and 55–63 years. Also, all analyses investigate both the impact of perceiving general under-skilling and the impact of perceiving under-skilling in regard to a specific type of skill. To describe the study population at baseline, x^2-tests were applied to test for differences between the two age groups in the prevalence of personal, health and work characteristics and NFR caseness. x^2-tests were also performed separately for each type of skill to test for differences between the two age groups in the distribution of skill match and under-skilling. To find out about the dynamics in skills between 2012 and 2014 among those who perceived themselves as under-skilled at baseline, x^2-tests investigated the prevalence of the three possible developments in the two age groups. Poisson regression analyses (with scaled deviance) were conducted to investigate the longitudinal association between perceived under-skilling in the October 2012 wave and NFR in the October 2014 wave. The continuous NFR scores, expressed as regression coefficients, were compared between under-skilled employees and employees perceiving a skill match. Three models were investigated: a crude model (model 1), a model adjusting for sex, educational level and self-perceived health (model 2) and a model additionally adjusting for the number of working hours per week, psychological job demands, decision latitude, co-worker social support and supervisor social support (model 3). We report unstandardized regression coefficients for the risk of a higher NFR and standard errors.

The longitudinal association between under-skilling in the October 2012 wave and the risk of NFR caseness in the October 2014 wave is investigated by means of Cox regression analyses. All prevalent cases of elevated NFR at study baseline were excluded from these analyses. Three models identical to those used for the Poisson regression analyses were investigated.

The longitudinal association between under-skilling and the risk of losing employment was also investigated using Cox regression analyses. As all respondents were employed at study baseline, no cases had to be excluded. The risk of losing employment was modelled for the October 2014 wave. Two models were investigated: a crude model (model 1) and a model adjusting for NFR baseline scores (model 2).

Table 1. Personal, health and work characteristics and NFR at the October 2012 baseline by age group (percentages)

	45–54 years (n = 574)	55–63 years (n = 537)	x^2 *p*-value
Personal characteristics			
Sex			
Male	66.7	79.0	< 0.0001
Female	33.3	21.0	
Educational level			
Low	0.4	0.6	0.529
Medium	15.6	17.8	
High	84.1	81.6	
Self-perceived health			
Poor	11.2	15.4	0.042
Good	88.8	84.6	
Work environment			
Number of working hours per week			
≥ 36	75.6	71.9	0.078
26–35	15.0	20.0	
≤ 25	9.4	8.1	
Psychological job demands			
Low	41.5	44.7	0.554
Medium	33.8	31.9	
High	24.7	23.4	
Decision latitude			
Low	16.5	20.4	0.112
Medium	37.1	32.0	
High	46.4	47.6	
Co-worker social support			
Low	21.4	27.2	0.025
High	78.6	72.8	
Supervisor social support			
Low	32.2	32.3	0.954
High	67.8	67.7	
Case of need for recovery			
No	82.2	78.7	0.145
Yes	17.8	21.3	

Source: Authors' calculations based on Maastricht Cohort Study data.

Cox regression analyses were performed to investigate the longitudinal association between being under-skilled and having strong retirement intentions in the October 2014 wave. All employees who had strong retirement intentions at study baseline were excluded. In this study, Cox regression analyses with a fixed time variable were performed to estimate hazard ratios, which are

Table 2. Prevalence of perceived under-skilling at the October 2012 baseline, unstratified sample and by age group (percentages)*

	Unstratified (n = 1,111)	45–54 years (n = 574)	55–63 years (n = 537)	x^2 *p*-value
General skill (mis)match (n = 844)				
Under-skilled	3.9	4.2	3.6	0.683
General knowledge on own occupation (n = 983)				
Under-skilled	21.1	21.9	20.2	0.523
General ICT skills (n = 1,029)				
Under-skilled	20.3	18.2	22.6	0.081
Work-related ICT skills (n = 847)				
Under-skilled	20.0	18.7	21.3	0.353
Communicative skills (n = 1,004)				
Under-skilled	23.2	23.1	23.3	0.957
Planning and matching work with colleagues (n = 906)				
Under-skilled	16.4	16.4	16.5	0.956
Notice, analyse and solve problems (n = 919)				
Under-skilled	18.0	18.8	17.0	0.483
Cope with changes in the job (n = 921)				
Under-skilled	24.0	23.8	24.2	0.894
Keep up with new knowledge and developments (n = 938)				
Under-skilled	27.0	27.2	26.7	0.852
Communicate in the English language (n = 714)				
Under-skilled	22.7	22.8	22.6	0.941

Note: * All percentages are expressed as a proportion of under-skilled in the under-skilled/match population. Over-skilled employees are excluded at baseline.

Source: Authors' calculations based on Maastricht Cohort Study data.

less prone to the problems encountered in the interpretation of odds ratios (Diaz-Quijano, 2012). Cox regression analyses were thus preferred over logistic regression analyses.

Results

Descriptive statistics

The characteristics of the study population at the October 2012 baseline are reported in table 1. The table shows statistical significance in the differences between the two age groups in terms of sex, self-perceived health and co-worker social support ($p<0.05$).[2]

[2] Appendix table A1 presents similar information with respect to all office workers. In this population, statistically significant differences between the two age groups were also observed in terms of sex, self-perceived health and co-worker social support.

Table 3. Dynamics of perceived specific under-skilling between October 2012 and October 2014, unstratified sample and by age group (percentages)

	Unstratified (n = 915)	45–54 years (n = 498)	55–63 years (n = 417)	x^2 *p*-value
General knowledge on own occupation (n = 161)				
Remained under-skilled	46.0	45.2	47.1	0.591
Transition to skill match	50.9	50.5	51.5	
Transition to over-skilled	3.1	4.3	1.5	
Planning and matching work with colleagues (n = 110)				
Remained under-skilled	32.7	36.7	28.0	0.546
Transition to skill match	56.4	51.7	62.0	
Transition to over-skilled	10.9	11.7	10.0	
Cope with changes in the job (n=159)				
Remained under-skilled	41.5	41.0	42.1	0.611
Transition to skill match	54.7	56.6	52.6	
Transition to over-skilled	3.8	2.4	5.3	
Keep up with new knowledge and developments (n = 191)				
Remained under-skilled	46.6	46.3	47.0	0.887
Transition to skill match	47.6	47.2	48.2	
Transition to over-skilled	5.8	6.5	4.8	

Source: Authors' calculations based on Maastricht Cohort Study data.

Table 2 reports the prevalence of perceived under-skilling both for the general under-skilling measure and for all the specific types of skill. No statistically significant differences were observed when comparing the two age groups.[3]

Dynamics in skill (mis)matches during the period October 2012–October 2014

Table 3 shows the dynamics of skill (mis)match among employees who perceived themselves as under-skilled in the October 2012 wave. The results indicate that for each type of skill, a considerable number of them transited from under-skilling to a skill match or to over-skilling during the two-year follow-up period. Again, no statistically significant differences in these transitions show up between the two age groups.

Need for recovery

Table 4 compares the continuous NFR scores – expressed as unstandardized regression coefficients (B) – of employees who perceived themselves to be under-skilled and those with a skill match. In the unstratified sample in all three

[3] Appendix table A2 presents similar information with respect to all office workers. In this population, no statistically significant differences were observed between the two age groups.

Table 4. Regression coefficients and standard errors for continuous NFR scores according to employees' perceived skill (mis)match (October 2012–October 2014), unstratified sample and by age group

	Model 1						Model 2						Model 3					
	Unstratified		45–54 years		55–63 years		Unstratified		45–54 years		55–63 years		Unstratified		45–54 years		55–63 years	
	B	S.e.	B	S.e.	B	S.e.	B	S.e.	B	S.e.	B	S.e.	B	S.e.	B	S.e.	B	S.e.
General skill (mis)match (n = 658)																		
Match	0		0		0		0		0		0		0		0		0	
Under-skill	0.762*	0.167	0.829*	0.210	0.679*	0.272	0.643*	0.172	0.712*	0.218	0.539	0.279	0.633*	0.170	0.750*	0.223	0.555*	0.272
General knowledge on own occupation (n = 758)																		
Match	0		0		0		0		0		0		0		0		0	
Under-skill	0.252*	0.093	0.237	0.123	0.276	0.141	0.188*	0.092	0.165	0.122	0.195	0.141	0.167	0.091	0.184	0.120	0.190	0.139
Work-related ICT skills (n = 652)																		
Match	0		0		0		0		0		0		0		0		0	
Under-skilled	0.193	0.104	.047	0.148	0.341*	0.148	0.148	0.101	0.075	0.142	0.228	0.146	0.151	0.100	0.067	0.140	0.264	0.144
Communicative skills (n = 770)																		
Match	0		0		0		0		0		0		0		0		0	
Under-skilled	0.277*	0.089	0.221	0.119	0.345*	0.135	0.235*	0.088	0.161	0.117	0.326*	0.133	0.139	0.088	0.075	0.119	0.197	0.131
Planning and matching work with colleagues (n = 698)																		
Match	0		0		0		0		0		0		0		0		0	
Under-skilled	0.265*	0.106	0.430*	0.135	0.051	0.170	0.235*	0.104	0.451*	0.131	–0.047	0.169	0.207*	0.102	0.395*	0.131	–0.005	0.168
Notice, analyse and solve problems (n = 703)																		
Match	0		0		0		0		0		0		0		0		0	
Under-skilled	0.084	0.106	–0.060	0.144	0.263	0.157	0.044	0.104	–0.055	0.142	0.154	0.157	–0.013	0.105	–0.111	0.142	00.049	0.160
Cope with changes in the job (n = 705)																		
Match	0		0		0		0		0		0		0		0		0	
Under-skilled	0.339*	0.090	0.385*	0.122	0.288*	0.132	0.220*	0.090	0.246*	0.125	0.182	0.133	0.129	0.091	0.137	0.132	0.131	0.130
Keep up with new knowledge and developments (n = 726)																		
Match	0		0		0		0		0		0		0		0		0	
Under-skilled	0.250*	0.088	0.195	0.119	0.318*	0.132	0.221*	0.087	0.166	0.119	0.294*	0.131	0.191*	0.086	0.164	0.119	0.213	0.130
Communicate in the English language (n = 530)																		
Match	0		0		0		0		0		0		0		0		0	
Under-skilled	0.046	0.114	–0.088	0.150	0.226	0.174	–0.005	0.111	–0.125	0.147	0.164	0.171	–0.020	0.110	–0.127	0.146	0.128	0.172

Notes: Model 1 = Crude; Model 2 = Adjusted for personal and health characteristics (sex, educational level and self-perceived health); Model 3 = Additionally adjusted for work characteristics (number of working hours per week, psychological job demands, decision latitude, co-worker social support, supervisor social support); * indicates statistical significance ($p < 0.05$).

Source: Authors' calculations based on Maastricht Cohort Study data.

Table 5. Hazard ratios and 95% confidence intervals for NFR caseness according to employees' perceived skill (mis)match (October 2012–October 2014)

	Model 1 (n = 748)		Model 2		Model 3	
	HR	95%CI	HR	95%CI	HR	95%CI
General skill (mis)match (n = 548)						
Match	1		1		1	
Under-skilled	5.20	2.02–13.33	4.94	1.91–12.75	4.76	1.78–12.69
General knowledge on own occupation (n = 628)						
Match	1		1		1	
Under-skilled	1.13	0.56–2.28	1.09	0.54–2.20	1.11	0.55–2.26
Work-related ICT skills (n = 534)						
Match	1		1		1	
Under-skilled	1.79	0.91–3.53	1.79	0.91–3.52	1.86	0.94–3.71
Communicative skills (n = 641)						
Match	1		1		1	
Under-skilled	1.20	0.61–2.37	1.17	0.59–2.32	1.05	0.52–2.11
Planning and matching work with colleagues (n = 575)						
Match	1		1		1	
Under-skilled	1.55	0.74–3.24	1.44	0.69–3.03	1.35	0.63–2.88
Notice, analyse and solve problems (n = 583)						
Match	1		1		1	
Under-skilled	0.54	0.19–1.53	0.52	0.18–1.46	0.45	0.16–1.31
Cope with changes in the job (n = 578)						
Match	1		1		1	
Under-skilled	1.11	0.53–2.32	1.00	0.47–2.11	0.91	0.42–1.97
Keep up with new knowledge and developments (n = 600)						
Match	1		1		1	
Under-skilled	1.39	0.71–2.72	1.39	0.71–2.71	1.27	0.64–2.51
Communicate in the English language (n = 447)						
Match	1		1		1	
Under-skilled	0.39	0.12–1.29	0.35	0.10–1.16	0.32	0.10–1.08

Notes: Model 1 = Crude; Model 2 = Adjusted for personal and health characteristics (sex, educational level and self-perceived health); Model 3 = Additionally adjusted for work characteristics (number of working hours per week, psychological job demands, decision latitude, co-worker social support, supervisor social support).
Source: Authors' calculations based on Maastricht Cohort Study data.

models, the NFR scores of employees who perceived general under-skilling in their job are statistically significantly higher than those of employees experiencing a skill match. The same goes for both age groups, except for the 55–63 group in model 2.

As regards the specific types of skills, perceived under-skilling in *general knowledge on own occupation* is found to be associated with statistically significant higher NFR scores for all workers in regression models 1

and 2. However, the NFR scores are not significantly higher when also controlling for various job characteristics (model 3). Perceived under-skilling in *work-related ICT skills* is associated with statistically significant higher NFR scores among the 55–63 age group, but only in model 1. Perceived under-skilling in *communicative skills* is associated with statistically significant higher NFR scores in models 1 and 2, both for all workers and for the 55–63 age group. Perceived under-skilling in *planning and matching work with colleagues* produces statistically significant higher NFR scores in all three models, both for all workers and for those in the 45–54 age group. Lacking skills to *cope with changes in the job* is associated with statistically significant higher NFR scores in the unstratified sample in models 1 and 2. Similar findings are observed for both age groups, although the difference in NFR scores is no longer statistically significant among those aged 55–63 in model 2. Finally, perceived under-skilling in *keep up with new knowledge and developments* is associated with statistically significant higher NFR levels in all three models including all workers. Similar findings are observed for the 55–63 age group, except in model 3 where its NFR scores are no longer statistically significant.

Table 5 reports our findings on the risk of experiencing elevated NFR. Compared to those perceiving a skill match, employees perceiving general under-skilling in their job have a statistically significant higher risk of NFR caseness in all three models, as expressed in the hazard ratios of 5.20 (95%CI = 2.02–13.33), 4.94 (95%CI = 1.91–12.75) and 4.76 (95%CI = 1.78–12.69) for models 1, 2 and 3, respectively. However, no statistically significant higher risk of NFR caseness can be observed for under-skilling in any of the specific types of skills.

Losing employment

As mentioned above, losing employment is defined as no longer being in wage employment and/or no longer being partly self-employed. Employees aged 55–63 years who experienced general under-skilling in their job had a statistically significant higher risk of losing employment during the follow-up period: HR = 3.22 (95%CI = 1.27–8.20) compared to those who experienced a general skill match (see table 6). After adjusting for NFR baseline scores, this risk remains borderline significant: HR = 2.64 (95%CI = 1.01–6.85). No statistically significant higher risk of losing employment is observed for any of the specific types of skills, neither in the unstratified sample, nor after age stratification.

Retirement intentions

Table 7 reports on the risk of having strong retirement intentions for each type of skill. No statistically significant hazard ratios are observed in any of the models, whether in the unstratified sample, or in the separate age groups.

Table 6. Hazard ratios and 95% confidence intervals for the risk of losing employment according to employees' perceived skill (mis)match (October 2012–October 2014), unstratified sample and by age group

	Model 1						Model 2					
	Unstratified (n = 915)		45–54 years (n = 498)		55–63 years (n = 417)		Unstratified		Age 45–54 years		Age 55–63 years	
	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI
General skill (mis)match (n = 700)												
Match	1		1		1		1		1		1	
Under-skilled	2.06	0.89–4.74	0.73	0.10–5.35	3.22	1.27–8.20	1.86	0.80–4.34	0.77	0.10–5.66	2.64	1.01–6.85
General knowledge on own occupation (n = 808)												
Match	1		1		1		1		1		1	
Under-skilled	1.02	0.62–1.67	0.63	0.27–1.50	1.40	0.76–2.58	0.99	0.60–1.63	0.64	0.27–1.54	1.28	0.69–2.37
Work-related ICT skills (n = 695)												
Match	1		1		1		1		1		1	
Under-skilled	0.95	0.55–1.64	0.93	0.39–2.25	0.93	0.46–1.85	0.92	0.53–1.59	0.94	0.39–2.27	0.86	0.43–1.72
Communicative skills (n = 824)												
Match	1		1		1		1		1		1	
Under-skilled	1.39	0.90–2.15	1.54	0.79–2.98	1.31	0.74–2.34	1.33	0.86–2.06	1.55	0.80–3.02	1.19	0.66–2.13
Planning and matching work with colleagues (n = 746)												
Match	1		1		1		1		1		1	
Under-skilled	1.16	0.67–1.98	1.43	0.66–3.12	0.96	0.45–2.04	1.10	0.64–1.90	1.52	0.68–3.37	0.90	0.42–1.92
Notice, analyse and solve problems (n = 755)												
Match	1		1		1		1		1		1	
Under-skilled	1.25	0.76–2.05	1.41	0.69–2.89	1.14	0.57–2.28	1.20	0.73–1.98	1.43	0.70–2.94	1.04	0.52–2.09
Cope with changes in the job (n = 754)												
Match	1		1		1		1		1		1	
Under-skilled	1.28	0.80–2.04	1.58	0.80–3.13	1.05	0.55–2.02	1.21	0.75–1.96	1.61	0.80–3.23	0.95	0.49–1.84
Keep up with new knowledge and developments (n = 773)												
Match	1		1		1		1		1		1	
Under-skilled	1.20	0.76–1.89	1.28	0.64–2.53	1.14	0.62–2.13	1.16	0.73–1.84	1.33	0.67–2.66	1.05	0.56–1.96
Communicate in the English language (n = 577)												
Match	1		1		1		1		1		1	
Under-skilled	0.98	0.55–1.75	0.76	0.31–1.85	1.23	0.58–2.64	0.97	0.55–1.74	0.77	0.32–1.88	1.20	0.56–2.57

Notes: Model 1 = Crude; Model 2 = Adjusted for NFR baseline score.
Source: Authors' calculations based on Maastricht Cohort Study data.

Table 7. Hazard ratios and 95% confidence intervals for the likelihood of having strong retirement intentions according to employees' perceived skill (mis)match (October 2012–October 2014), unstratified sample and by age group

	Unstratified (n = 740)		45–54 years (n = 406)		55–63 years (n = 334)	
	HR	95%CI	HR	95%CI	HR	95%CI
General skill (mis)match (n = 570)						
Match	1		1		1	
Under-skilled	1.75	0.71–4.31	2.40	0.74–7.73	1.22	0.29–5.02
General knowledge on own occupation (n = 660)						
Match	1		1		1	
Under-skilled	1.39	0.89–2.18	1.20	0.63–2.31	1.65	0.89–3.04
Work-related ICT skills (n = 562)						
Match	1		1		1	
Under-skilled	1.19	0.73–1.93	1.08	0.54–2.17	1.29	0.66–2.55
Communicative skills (n = 674)						
Match	1		1		1	
Under-skilled	1.30	0.84–2.00	1.15	0.61–2.18	1.46	0.80–2.67
Planning and matching work with colleagues (n = 605)						
Match	1		1		1	
Under-skilled	1.30	0.77–2.21	1.29	0.62–2.68	1.32	0.62–2.85
Notice, analyse and solve problems (n = 611)						
Match	1		1		1	
Under-skilled	1.44	0.90–2.32	1.77	0.94–3.32	1.16	0.56–2.40
Cope with changes in the job (n = 607)						
Match	1		1		1	
Under-skilled	1.02	0.62–1.67	1.05	0.52–2.12	0.99	0.49–1.98
Keep up with new knowledge and developments (n = 629)						
Match	1		1		1	
Under-skilled	0.99	0.63–1.56	0.68	0.34–1.36	1.43	0.78–2.62
Communicate in the English language (n = 470)						
Match	1		1		1	
Under-skilled	1.15	0.67–1.97	0.82	0.35–1.88	1.56	0.77–3.19

Source: Authors' calculations based on Maastricht Cohort Study data.

Discussion

Main findings

The aim of this study was to investigate the prevalence of under-skilling, its dynamics over a two-year period and its effects on NFR, the risk of losing employment and retirement intentions among workers aged 45–54 and 55–63 years. Although differences between these two age groups were

observed in personal and work environment characteristics, the prevalence of their perceived under-skilling did not differ at a statistically significant level.

In our longitudinal analyses, perceived under-skilling was associated with higher levels of NFR. Compared to experiencing a skill match, experiencing general under-skilling in the job and experiencing under-skilling in certain specific skills were both associated with higher levels of NFR, particularly in regard to *general knowledge on own occupation, work-related ICT skills, communicative skills, planning and matching work with colleagues, coping with changes in the job* and *keeping up with new knowledge and developments*. However, perceived under-skilling for *noticing, analysing and solving problems* and *communicating in the English language* was not found to be associated with higher levels of NFR. It can thus be concluded that under-skilling in specific skills is variously associated with NFR. Consequently, it is important to distinguish between specific skills when investigating and/or interpreting skill (mis)matches. Furthermore, different associations were observed in the two age groups, which might be an indication that the impact of under-skilling on NFR varies over the course of a worker's career.

Experiencing general under-skilling in the job was also found to be associated with the risk of NFR caseness, whereas experiencing under-skilling in the specific skills did not result in a higher risk of NFR caseness. However, only a small percentage of employees experienced general under-skilling, whereas larger percentages perceived themselves to be under-skilled in specific skills. This suggests that those who experience general under-skilling should be considered a distinct group in which adverse outcomes are explicitly demonstrable. To find out whether these employees also differed in terms of other characteristics, the personal, health and work characteristics of employees experiencing general under-skilling were compared with those of employees who experienced a general skill match. Our results show that employees experiencing general under-skilling also reported higher levels of psychological job demands and lower levels of decision latitude (specific results are not shown here but are available from the authors on request). Another explanation for the absence of NFR caseness among employees who perceived themselves as lacking in specific skills might be that although their NFR levels were often higher than those of employees who experienced a skill match, those levels were not sufficiently high to qualify as actual cases of elevated NFR according to our definition of caseness.

The present study also demonstrated that experiencing general under-skilling in the job was associated with the risk of losing employment. This is in line with Klimplová (2012) study, which found that under-skilled employees who were not able to adapt to changing conditions or technological changes in their job were at risk of job loss. After adjusting for NFR baseline scores in the association between under-skilling and losing employment, this risk was found to be only borderline significant. High levels of NFR might therefore be a contributing factor in the connection between under-skilling and the risk of losing employment. A higher risk of losing employment was, however, only

observed in the oldest age group. As older employees have less access to on-the-job training (OECD, 2005), this might possibly explain why the under-skilling is associated with more adverse outcomes in this age group. Younger employees might be able to overcome (the severity of) under-skilling by availing themselves of training opportunities to upgrade their skills, and might therefore be less at risk of losing their employment.

Retirement intentions were not stronger among employees who experienced under-skilling than among those who experienced a skill match. A possible explanation for this finding might be that any under-skilled employees with strong retirement intentions had already left the labour force by the time of the survey. Furthermore, since multiple underlying reasons have been found to be associated with the decision to retire early (Reeuwijk et al., 2013), such as financial opportunities to retire, high work pressure and willingness to spend more time with family, the effect of under-skilling per se on retirement intentions might have remained concealed.

During the two-year follow-up period, the dynamics of skill (mis)match were highly visible: a considerable number of employees who perceived themselves to be under-skilled at study baseline underwent a transition to a perceived skill match or to over-skilling. This suggests that significant numbers of under-skilled workers recover by training and/or learning at work, as shown by Allen and de Grip (2012). However, it should be noted that in our study, a one-point change on the five-point scale indicated a transition, whereas it remains uncertain whether a change of one point on this scale can be considered a relevant difference.

Different selection processes might have taken place in this study. In particular, employees who feel that their current job does not match their personal health or disposition might change jobs (or job tasks) or leave the labour force (i.e. a secondary "healthy worker effect"). An indication of such selection was observed in the oldest age group where those who experienced general under-skilling in their job had a higher risk of losing their employment than did employees who experienced a skill match. This may possibly result in a self-selected group of older employees who do not experience (severe) under-skilling, or who are able to cope well with under-skilling, and therefore remain in the labour force. Also, we observed differences between the age groups which might possibly (partially) be explained by selection effects as well. Another indication that selection processes may have occurred is that a large number of employees who were under-skilled at baseline underwent a transition during the follow-up period and experienced a skill match two years later. These employees might possibly have changed jobs or recovered from under-skilling through training and/or learning at work.

Baltes, Staudinger and Lindenberger (1999) suggest that older employees are often able to maintain a high level of functioning in the job because they rely to a greater extent on "selection, optimization and compensation" strategies than do younger workers. Such strategies imply that older workers are more likely to focus on a reduced number of achievable tasks (i.e. selection)

while at the same time committing themselves more strongly to this limited number of tasks (i.e. optimization). Also, when these strategies are no longer sufficient, older workers tend to rely more heavily on external aid, such as support from co-workers (i.e. compensation), to maintain their overall level of functioning in the job. This might explain why in some cases under-skilling was only found to have a statistically significant association with higher NFR in the 45–54 age group, and not in the 55–63 age group. However, for some specific skills, perceived under-skilling was only found to be associated with higher NFR in the oldest age group (e.g. *keeping up with new knowledge and developments*). A possible explanation might be that individuals in this age group experienced prolonged under-skilling, which may, in turn, be more strongly associated with adverse outcomes. In conclusion, selection effects might have taken place during the follow-up period, which might have resulted in an underestimation of the true impact of under-skilling on our outcome measures.

Strengths and limitations

A major strength of this study is that our sample allowed for the prospective investigation of the effects of perceived under-skilling on NFR, which have not been studied before. We were also able to investigate the effects of both general under-skilling in the job and under-skilling in specific types of skill on various outcome measures such as the risk of losing employment and retirement intentions, while taking into account a variety of confounders. The dynamics of skill (mis)match were illustrated as well.

The separate investigation of general under-skilling and under-skilling in specific types of skills appeared to be a valuable distinction, since the results of these approaches differed: while general under-skilling was less prevalent than specific under-skilling, its impact seemed stronger. Although a comprehensive approach was used to investigate skill (mis)match, it should be acknowledged that there are multiple ways of measuring this. In the case of self-reported assessment, as in our study, skill (mis)matches are subjectively measured and therefore vulnerable to measurement errors, though the advantage of this method is that the skill (mis)match is specifically measured for the job of the respondent and is up to date (Flisi et al., 2014). Yet more objective measures (e.g. job analysis technique) also have drawbacks: besides being expensive, the reliability of such overall measures – which are assumed to hold for all jobs within an occupation – is doubted in the literature. To date, there is no widely accepted measure of skill (mis)match (Perry, Wiederhold and Ackermann-Piek, 2014).

Our study only investigated skills that were assumed to be relevant for employees working in an office environment. For example, an adequate level of physical capacity to perform the job might be a relevant skill in work settings such as the building industry, but need not to be investigated among office workers. Possibly, such skills might be differently associated with the risk of losing one's job or employees' retirement intentions. Furthermore,

our initial sample also comprised employees who experienced over-skilling in their job. Although investigating the impact of over-skilling was outside the scope of this study, it should be noted that over-skilling is also associated with adverse outcomes, including a higher rate of cognitive decline (de Grip et al., 2008).

Although we were able to define employees as under-skilled, the underlying cause(s) of their under-skilling were not assessed. There might indeed be various reasons why under-skilling might arise among employees (e.g. skill obsolescence, change of job tasks), and it remains unclear whether under-skilling caused by different underlying reasons is differently associated with various outcomes. Also unknown in this study is the duration of under-skilling among employees, though it may well be that the cumulative effects of under-skilling or different durations of under-skilling might be differently associated with outcomes.

In the present study, all employees were originally employed in larger firms (> 100 employees) and all were in paid employment at study baseline. Employees in larger companies participate in training more often than do those employed in smaller companies. Moreover, employees are more likely to be involved in training than the self-employed (Pleijers and de Winden, 2014). The employees in our sample might therefore have had above-average opportunities to sustain and upgrade their skills, which might in turn have affected the observed associations between being under-skilled and the various outcomes. Also, since the vast majority of the firms covered by our analyses are located in the Netherlands, the findings of this study should be considered in the Dutch context. For example, the impact of under-skilling on outcomes such as retirement intentions and the risk of losing employment might be affected by national legislation and pension schemes, and country-specific demographic factors and differences in economic structure (European Commission, 2012). However, an advantage of this study is that it also investigated the impact of under-skilling on NFR, a measure that should be considered less prone to such contextual factors.

Concluding remarks

Perceived under-skilling in one's job was found to be associated with higher levels of NFR among office workers over time. High NFR is undesirable in itself and has been identified as a precursor of adverse health and labour outcomes in earlier studies (van Amelsvoort et al., 2003; de Croon, Sluiter and Frings-Dresen, 2003). As the etiology and duration of under-skilling were not investigated in the present study, a suggestion for future research would be to explore the underlying causes of under-skilling, since preventive measures and interventions targeting those causes might reduce or prevent under-skilling and subsequent adverse outcomes. While under-skilling was also found to be associated with the risk of losing employment, no associations with strong retirement intentions were observed. However, since we did find indications

of "healthy worker" selection effects, these findings might be an underestimation of actual outcomes.

An important contribution of this study is that different approaches to skill (mis)match assessment resulted in different findings. The methods used to investigate skill (mis)match should therefore be considered carefully. Under-skilling in some particular skills was found to be associated with adverse outcomes, whereas no associations with adverse outcomes were observed for other skills. Also, adverse outcomes were observed in two different age groups. To achieve sustainable employment, the course of (different types of) under-skilling should be monitored throughout workers' careers in order to counter the negative consequences of under-skilling in a timely manner.

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Appendix

Table A1. Personal, health and work characteristics and NFR of all office workers at October 2012 baseline, by age group (percentages)

	45–54 years (n = 758)	55–63 years (n = 694)	x^2 *p*-value
Personal characteristics			
Sex			
Male	66.2	78.2	< 0.0001
Female	33.8	21.8	
Educational level			
Low	0.5	1.6	0.067
Medium	17.9	20.1	
High	81.5	78.2	
Self-perceived health			
Poor	11.7	16.4	0.010
Good	88.3	83.6	
Work environment			
Number of working hours per week			
≥ 36	74.4	72.1	0.084
26–35	15.4	19.4	
≤ 25	10.2	8.4	
Psychological job demands			
Low	44.3	46.9	0.616
Medium	32.3	30.7	
High	23.5	22.5	
Decision latitude			
Low	19.3	22.8	0.171
Medium	36.1	32.4	
High	44.6	44.8	
Co-worker social support			
Low	21.7	27.1	0.015
High	78.3	72.9	
Supervisor social support			
Low	34.0	34.7	0.780
High	66.0	65.3	
Case of need for recovery			
No	82.1	78.0	0.050
Yes	17.9	22.0	

Source: Authors' calculations based on Maastricht Cohort Study data.

Table A2. Prevalence of perceived under-skilling among all office workers at the October 2012 baseline, unstratified sample and by age group (percentages)*

	Unstratified (n = 1,452)	45–54 years (n = 758)	55–63 years (n = 694)	x^2 *p*-value
General skill (mis)match (n = 1,074)				
Under-skilled	4.2	4.2	4.2	0.999
General knowledge on own occupation (n = 1,241)				
Under-skilled	20.3	21.0	19.5	0.512
General ICT skills (n = 1,212)				
Under-skilled	17.8	16.3	19.5	0.146
Work-related ICT skills (n = 1,058)				
Under-skilled	18.5	17.6	19.5	0.421
Communicative skills (n = 1,280)				
Under-skilled	22.3	22.0	22.7	0.763
Planning and matching work with colleagues (n = 1,164)				
Under-skilled	16.3	15.9	16.8	0.698
Notice, analyse and solve problems (n = 1,170)				
Under-skilled	17.4	17.6	17.1	0.832
Cope with changes in the job (n = 1,185)				
Under-skilled	24.0	23.2	24.7	0.539
Keep up with new knowledge and developments (n = 1,206)				
Under-skilled	26.1	25.8	26.4	0.804
Communicate in the English language (n = 898)				
Under-skilled	21.5	21.3	21.7	0.898

Notes: * All percentages are expressed as a proportion of under-skilled in the under-skilled/match population. Over-skilled employees are excluded at baseline.

Source: Authors' calculations based on Maastricht Cohort Study data.